Machinery MESsages

Low vibration levels do not always indicate a healthy machine

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Shaft vibration amplitude, frequency and phase information provides the vibration analyst with significant information concerning the overall mechanical integrity of a machine. Additional information is contained in data which relates average radial shaft position to bearing clearance. Yet, often times this important information is overlooked.

Typically, overall vibration amplitude is used as the sole indicator of machine acceptability. Most of us intuitively relate high indications on vibration monitors with a potential machine malfunction. Conversely, we usually assume that low vibration amplitudes indicate acceptable mechanical performance.

In most cases, this is a correct assumption, but you should not be lulled into a false sense of security. Just the opposite case may be true.

Hidden, and potentially catastrophic, problems can go undetected unless the dc gap voltage information from radially-mounted proximity probes is analyzed. In the last three years, I personally have been involved in four cases where dc gap voltage information accounted for machinery saves during startup and was the key to diagnosing several problems long before they significantly affected machinery operation.

Analyzing dc gap voltage

Evaluation of dc gap voltage enables you to determine the shaft centerline position relative to the bearing centerline and actual mechanical clearance limits. This information is easily obtained from a pair of proximity probes mounted near a radial bearing.

The dc gap voltage measurement requires at least two sets of readings. The first set must be acquired while the machine is at rest.

An additional set is acquired when the machine reaches operating conditions. Other sets of readings can be acquired during transient operation (start-up and/or shutdown) and under steady-state operation for trending purposes.

The shaft position change relative to a given probe can be determined by dividing the change in gap voltage by the scale factor of the transducer. Once this has been accomplished for both transducers, a vector addition allows the change in shaft centerline position to be determined. Since the initial shaft position was known, then the position of the shaft with respect to the bearing geometry is determined.

Case history

A recent case illustrates the importance of dc gap voltage information. A chemical company overhauled a 10,000 rpm barrel compressor used in a methane gas compressor train. The compressor bearings were tilting pad with a spherically-seated bearing housing. An anti-rotation pin was located at the top center of the bearing assembly.

Startup vibration levels were under 0.7 mil (see Figure 1), and the company's engineering personnel were satisfied that the unit had been successfully overhauled.

Bently Nevada's Mechanical Engineering Services (MES) had been commissioned to acquire startup and steady-state data on the compressor to ensure its mechanical reliability for extended operation. The dc gap voltage data acquired by MES indicated a potential problem that was not evident from the dynamic vibration data.

Using a voltmeter, a set of dc gap voltage readings was acquired at all XY probe locations while the machine was at rest. Upon reaching operating speed, a second set of readings was taken. Shaft centerline position changes were calculated for each bearing and then compared to the nominal bearing

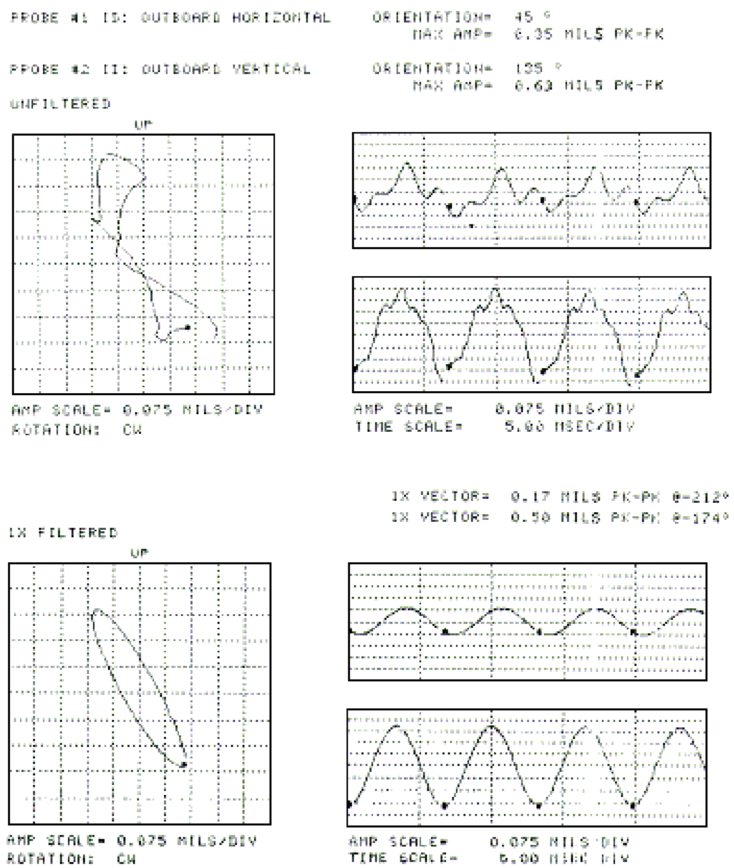
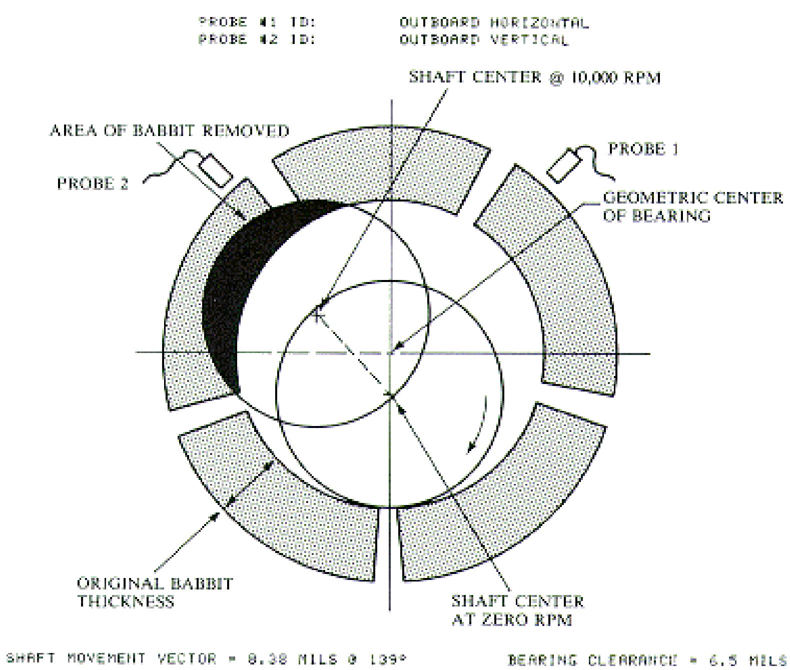


Figure 1



#	RPM	TIME	DC VALUES (Volts) PROBE #1	PROBE #2
1	0	1100	-9.26	-12.40
2	10000	1115	-9.42	-10.73

Figure 2

clearances. This comparison indicated that the clearance had been exceeded on the compressor outboard bearing (see Figure 2).

The machine was shutdown and the outboard bearing was inspected. Upon removing the bearing cap, it was found that the bearing had been misaligned (cocked) by an improperly sized anti-rotation pin, which caused the bearing to be wiped severely.

The pads were replaced and the anti-rotation pin was correctly mated to its retaining hole. The machine was back on line within four hours. The calculation of the shaft centerline position change was crucial to identifying this problem before further machinery damage occurred.

The importance of shaft center–line information

From this example, we can see that shaft centerline position information is essential for determining overall machinery condition. Other machine malfunctions which may be detected by using shaft position measurements include bearing wear, bearing degradation caused by electrostatic discharge, external and internal preloads and loose bearing fits. This information also can be used to calculate the shaft eccentricity ratio and attitude angle. These parameters will be discussed in a future column.

Calculating shaft centerline position is a relatively straight-forward procedure, requiring only basic knowledge of probe orientation, transducer conventions, and scale factor. In the next issue, we will discuss the step-by-step procedure for making this calculation.

Additional information is available in several Bently Nevada Applications Notes. They can be ordered by checking the following numbers on the return card:

Plotting Average Shaft Centerline Position, L0248.

Shaft Position Changes Reveal Machinery Behavior/Malfunctions, L0246.

Preloads on Rotating Shafts, L0243.

Mechanical Degradation Due to Electrostatic Shaft Voltage Discharge, L0247.

7200 Series Special Options, L0122.